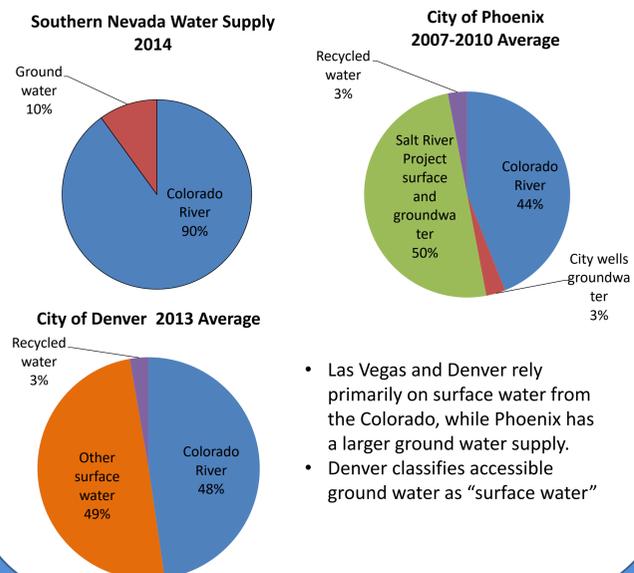


Solutions for Urban Water Sustainability Transitions: Comparison of Cities Dependent on Water from the Colorado River Basin

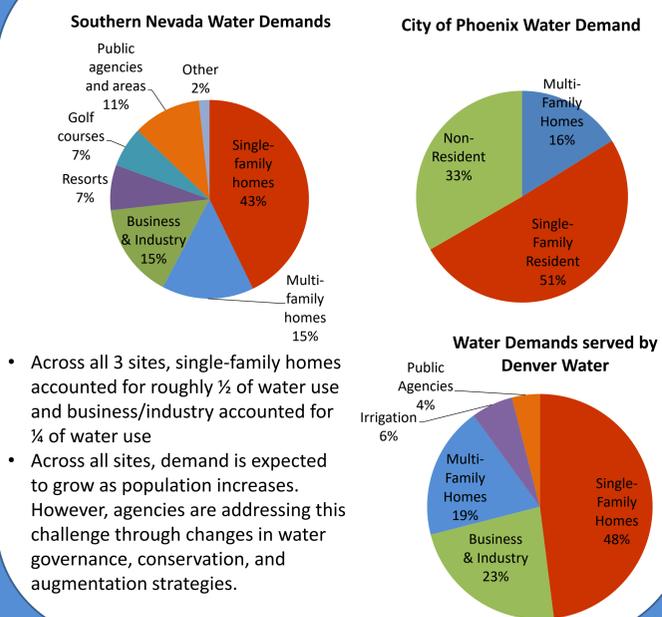
Danielle Chipman¹, Rhian Stotts², Charlotte Till², Kelli Larson³, Amber Wutich², and Dave White⁴

¹School of Sustainability; ²School of Human Evolution and Social Change; ³School of Geographical Sciences and Urban Planning; ⁴School of Community Resources and Development

Water Supply



Water Demands



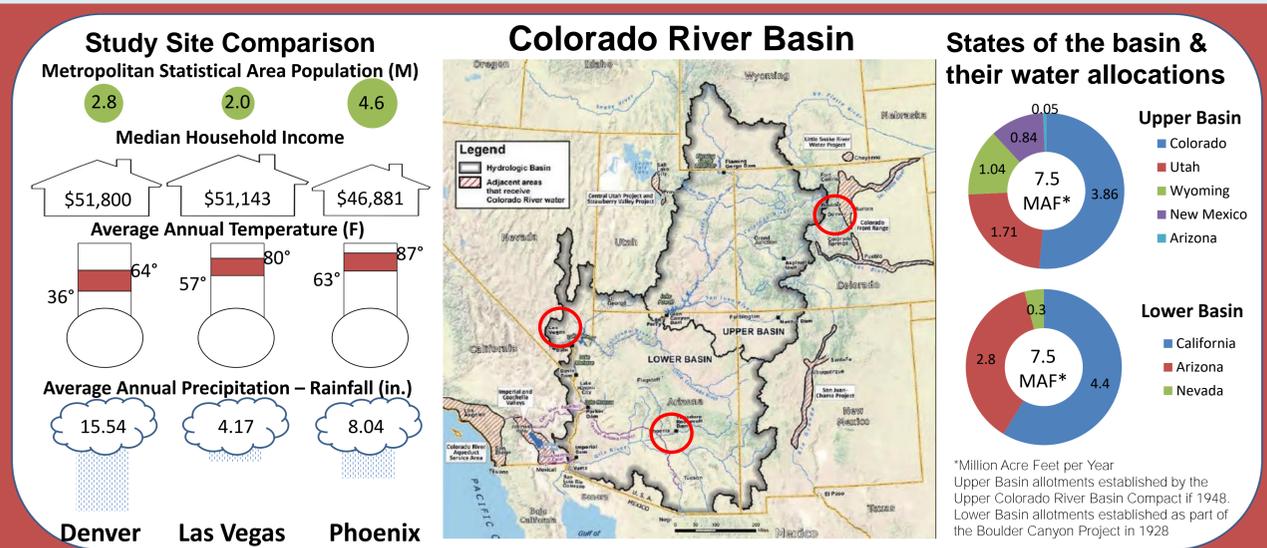
Local/Regional Water Actors

Phoenix	Over 100 public (municipal) and private (for-profit) water utilities and several regional planning agencies.
Denver	Denver Water supplies water for the county and 70 suburban water districts. Each district/suburb has its own supply allocation.
Las Vegas	Southern Nevada Water Authority (SNWA)

Las Vegas has a highly centralized system through the Southern Nevada Water Authority allowing Las Vegas to have better negotiating power over its Colorado River allocation. In Phoenix, there are several regional planning agencies such as the Central Arizona Water Conservation District, the Salt River Project, and the Phoenix Active Management Area, but water governance is generally highly fragmented between water providers and these agencies. Denver lacks any regional planning agencies but is dominated by Denver Water which is the largest water utility and contracts out to many other communities. Water courts in Denver, and Colorado more broadly, are extremely active in maintaining claims under prior appropriation laws.

RESEARCH GOALS

To understand how residents, institutions, and economic dynamics shape urban water systems and the implications for sustainability transitions across Phoenix, Las Vegas, and Denver. This poster presents a preliminary comparison between the cities of interest, exploring Water Supply and Demand as well as risks and potential future threats to these across the three locations. Water Management is a primary interest of this work, and the identification of innovations in the governance, conservation, and augmentation of water resources – to both increase supplies, and reduce demands across these sites will help us to identify potential solutions to water concerns within the basin.



Climate Change Scenarios/Threats

Identified Current and Future Threats to the Water Supply

	Population Growth	Increasing Heat	Unpredictable Precipitation	Increased Evaporation	Diminished Stream Flows	Reduced or Altered Snowfall	Pollutant Concentrations
Las Vegas	★ ★ ★	★ ★	★ ★ ★	★	★ ★ ★	★	
Phoenix	★ ★ ★	★ ★ ★	★		★	★	
Denver	★		★ ★ ★		★	★ ★ ★	★

No star = not prominent threat ★ = Identified as concern, some actions identified ★ ★ ★ = Most concern and is a top priority for the area

- Climate change will be a driver of many of these threats (e.g. increasing heat, changes in precipitation and snowfall, increased evaporation, and diminished stream flows).
- Drought, flash floods, and changes in water quality and quantity are likely impacts from many of these threats
- All three sites identified population growth, unpredictable precipitation, diminished stream flow, and reduced or altered snowfall as concerning or serious threats. Rain and snow fall directly impact stream flow, and population growth puts increasing pressure on existing already strained systems.
- Two methodologies are being engaged with by all sites to secure water for current and future generations; Increasing Supplies, and Reducing Demands. Examples of these efforts are shown on the right of this poster. Innovations are taking place at the city, county, state, and inter-state levels.

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Innovations in Water Management

Increasing Water Supply

Innovation	Denver	Las Vegas	Phoenix
Long distance water transport	X		X
Wastewater reclamation and reuse	X	X	X
Intrastate water sharing	X	X	X
Interstate Water Banking		X	X
Desalination partnerships		X	X
Shortage sharing	X	X	X

- Long distance water transport:** AZ and CO both transport Colorado River water over long distances. In CO, this water is delivered through transmountain diversions to the Front Range. In AZ, water is diverted 336 miles via the Central Arizona Project (CAP) canal.
- Wastewater reclamation and reuse:** All three cities practice direct reuse through the delivery of treated wastewater to golf courses and parks for irrigation and power plants for cooling. Las Vegas and Phoenix also practice indirect reuse. In Las Vegas, this is through the return of treated wastewater to Lake Mead for return flow credits. In Phoenix, indirect reuse is practiced through aquifer recharge. Denver Water does not engage in indirect reuse but some municipalities plan to release treated wastewater into the river system.
- Water sharing:** Each city has developed water sharing agreements in quite different ways. In Las Vegas, the water utilities came together to form the Southern Nevada Water Authority. Denver Water, as an artifact of prior appropriation, has the most water rights and thus contracts out with other providers. Phoenix has entered into a historical water sharing agreement with Phoenix; municipalities also collaborate on treated wastewater/reuse.
- Water Banking:** SNWA has stored a limited supply in the Las Vegas Valley aquifer and has stored water in Arizona and California's aquifers. Denver is currently examining the feasibility of storing water in bedrock aquifers.
- Desalination:** SNWA, CAP, and the Metropolitan Water District of Southern California partnered in the construction of the Yuma Desalting Plant to assess the feasibility of increasing storage in the Colorado river by supplementing water obligations to Mexico. It has been operated on two occasions since construction was completed in 1992 but is currently not in operation. AZ, CA, NV, and Mexico have also discussed the feasibility of constructing a desalination plant in Mexico to provide piped water or water exchanges.
- Shortage sharing:** In 2007, the seven Colorado Basin States and the Bureau of Reclamation agreed to stipulations for water allocations if/when shortages occur. These guidelines coordinate the management of Lake Powell and Lake Mead, outlining reductions in supply for the Lower Basin states, establish new surplus procedures, and allow for states to develop Intentionally Created Surplus (ICS), i.e. store water in Lake Mead for later use.

Reducing Water Demand

Innovation	Denver	Las Vegas	Phoenix
Water pricing	X	X	X
Education and outreach	X	X	X
Water use restrictions	X	X	X
Financial incentives	X	X	X

- Water pricing:** The City of Phoenix's water pricing is flat with seasonal variation and several cities in the metropolitan area employ inclining block rates, which are considered the most effective in communicating the value of water to customers. In Las Vegas, SNWA member agencies charge higher rates for water as use increases. Denver Water also uses a tiered rate structure though in 2016, a new, controversial pricing structure was introduced that raised rates for those using the least and lowered rates for those using the most water.
- Education and outreach:** Both the Cities of Phoenix and Gilbert were recognized by the EPA in 2002 as exemplars for their conservation efforts, including their conservation education programs. Las Vegas has reduced per capita water consumption by 43% over the past decade, in part by teaching residents about water-smart landscaping practices and water efficiency. Denver Water's long running "Use Only Water Your Need" campaign has largely been successful, resulting in 40-year low in water use in 2014.
- Water use restrictions:** Las Vegas has enacted a number of landscape restrictions focusing on the amount of turf allowed in new construction, the prohibition of xeric landscaping, strict prohibitions on water features, and restricted landscape irrigation during the hottest parts of the day. Denver Water has a number of summer water rules that are enforced through fines. Many cities in the Phoenix area, as well as HOAs, have ordinances that focus on landscaping of development projects that promote Xeriscapes. Phoenix municipalities have generally been reluctant to implement more large scale restrictions, however.
- Financial incentives:** In 2014, the Department of the Interior, Denver Water, the Central Arizona Project, the Southern Nevada Water Authority, and the Metropolitan Water District of Southern California created the Colorado River Conservation Partnership, a pilot program to pay users to cut consumption. In Las Vegas, the SNWA pays customers to remove turf and replace it with desert landscaping through the Water Smart Landscaping Program. Several municipalities in the Phoenix area have created a variety of financial incentive programs including plumbing retrofitting assistance and landscape rebates.